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New approaches for improving energy efficiency in the Brazilian industry

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ABSTRACT

The Brazilian government has been promoting energy efficiency measures for industry since the eighties but with very limited returns, as shown in this paper. The governments of some other countries dedicated much more effort and funds for this area and reached excellent results. The institutional arrangements and types of programmes adopted in these countries are briefly evaluated in the paper and provide valuable insights for several proposals put forward here to make more effective the Brazilian government actions directed to overcome market barriers and improve energy efficiency in the local industry. The proposed measures include the creation of Industrial Assessment Centres and an executive agency charged with the coordination of all energy efficiency programmes run by the Federal government. A large share of the Brazilian industry energy consumption comes from energy-intensive industrial branches. According to a recent survey, most of them have substantial energy conservation potentials. To materialize a fair amount of them, voluntary targets concerning energy efficiency gains should start to be negotiated between the Government and associations representing these industrial branches. Credit facilities and tax exemptions for energy-efficient equipment's should be provided to stimulate the interest of the entrepreneurs and the setting-up of bolder targets.

1. Introduction

Energy efficiency policies have been seen recently by the Energy Ministers from the International Energy Agency (IEA) countries as having a critical role in addressing energy security, climate change and economic objectives.

Within this context, the Agency recommended 25 energy efficiency policies to the G8 in Hokkaido-Toyako Summit in 2008 in seven priority areas: buildings, appliances, lighting, transport, industry, energy utilities and cross-sectoral issues (Jollands et al., 2010). The recommendations regarding industry and the cross-sectoral ones are discussed in this paper, in what concerns their application to Brazil.

The aim of this paper is to carry out a review of Brazilian industrial energy policies. To begin with, the main approaches the governments and other stakeholders use worldwide to promote energy efficiency gains in industry are presented. A synthetic critical appraisal of the Brazilian government policies and programmes in this area follow next. The little progress observed so far in several industrial energy-efficiency indicators in the country contrasts with large energy conservation technical potentials of energy-intensive industrial branches estimated by Bajay et al. (2009). Based then on comparisons between the Brazilian experience with energy efficiency programmes in industry and successful experiences of several other countries with such programmes, the authors of this paper propose a new energy policy mix for Brazil's industry.

2. The main instruments employed worldwide to foster energy efficiency gains in industry

Energy efficiency can be improved at site level in three main ways: employing more efficient technology, changing to more efficient behaviour, and converting to alternative fuels or production/transport/consumption routes that provide the same service

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consuming less energy. In order to achieve this, the governments address energy policies. According to Thollander et al. (2012), these policies can be categorized as administrative, economical and promoting R&D. The governments of many countries have often fostered the market for energy services through energy service companies (ESCOs) or let the market be ruled via demand side management (DSM) involving energy supply utilities. For energy-intensive industries voluntary agreements, coupled with energy audits, have played a major role. Energy audit programmes offering energy audits for small- and medium-sized industry and energy efficiency networks are also common (Thollander et al., 2012; Anderson and Newell, 2004; Bertoldi, 2001; Backlund et al., 2012; Bertoldi and Rezessy, 2011; Stenqvist and Nilsson, in press; Lindén and Carlsson-Kanyama, 2002; Tanaka, 2011; Koewener et al., 2011; Price and Lu, 2011; Thollander et al., in press).

Bajay and Sant'Ana (2010) found out the following approaches as the main instruments the governments and other stakeholders of 13 countries, plus the European Union as a whole have been using to promote energy efficiency gains in their industry:

- Diffusion, for industry staff, of technical, economic and financial information about efficient equipment and practices, through leaflets, booklets, books, handbooks, data bases and softwares;
- Providing courses about energy management and energy conservation measures in industry;
- Total or partial financing, through public funds or tariff rebates, of energy audits in industrial premises;
- Credit facilities for efficient industrial equipment;
- Setting-up of minimum energy performance standards for some general-use equipment in industry;
- Mandatory utility end-use energy efficiency schemes, including industrial consumers, with targets to be reached and verification procedures for the energy savings achieved;
- Fostering the participation of Energy Service Companies (ESCOs) and their performance contracts in industrial energy efficiency programmes;
- Licensing ESCOs and allowing them to issue certificates, recognized by the government, concerning the energy savings actually obtained in their performance contracts;
- Tax incentives for efficient industrial equipment;
- Diffusion of technical, economic and financial information about efficient industrial processes for some products (benchmarking);
- Voluntary agreements between government and industrial associations to implement energy efficiency programmes in industry, particularly in the energy-intensive branches;
- Funding of research and development projects concerning efficient industrial equipments and processes;
- Adoption of energy management codes in industry, compatible with the quality code ISO9000 and the environmental code ISO14000; and
- Legislation and regulation regarding mandatory energy efficiency programmes in industry.

Most of the countries studied by Bajay and Sant'Ana (2010) have industrial energy efficiency programmes for the energy-intensive branches and for small and medium companies and, usually, different approaches are used for each of them.

The great majority of the energy efficiency programmes for industry evaluated by Bajay and Sant'Ana (2010) were conceived by government bodies. The most successful of them have partnerships with industrial associations.

3. Government actions to promote energy efficiency in the Brazilian industry and the limited results obtained so far

The National Programme for Electricity Conservation (Procel) was the first systematic initiative to promote the efficient use of electricity in Brazil. The objectives of Procel's industrial programme are: (i) the support for the various industrial branches in improving their energy performance; (ii) the selection of industrial plants to carry out new, energy-efficient, projects and; (iii) the dissemination of information regarding successful projects, aiming their multiplication. No tax and credit incentives for the interested companies are available within this programme.

The Conpet programme was created on July 18, 1991, by a Presidential Decree with the aim of promoting the efficient use of petroleum and natural gas in the whole chain of the oil and gas industries, including both public and private premises.

The budgets and staffs of Procel and Compet dedicated to their industrial activities are very small and there are very few people responsible for energy efficiency policies and coordinating Procel and Compet at the Brazilian Ministry of Mines and Energy.

In spite of these government initiatives to foster energy efficiency in the Brazilian industry, the results obtained so far have been very limited, as shown by some energy efficiency and CO_2 emissions indicators in Table 1.

This table shows the values of the same indicators for Brazil, United States, France and China from 1990 to 2010. The United States and France were chosen because of the remarkable improvements the industry of these countries achieved in several of the indicators of Table 1, while in China, the fastest growing industry of a developing country also reaped substantial energy efficiency gains, according to some of these indicators. Different from what happened to most of the energy intensity, unit energy consumption and specific CO_2 emissions indicators for these three countries, the values of the corresponding indicators for Brazil either increased or did not decrease significantly over the last three decades.

4. Technical energy saving potentials in the Brazilian industry

Contrasting with the little progress observed so far in the energy efficiency of the Brazilian industry, there is a lot of room for future advances in this area. Table 2 shows both the absolute and relative electricity and heat conservation technical potentials of energy-intensive industrial branches in Brazil. They were estimated by Bajay et al. (2009), in a project carried out by the Interdisciplinary Centre for Energy Planning, at the State University of Campinas, for the Brazilian Confederation of Industry (CNI). The second column of the table indicates the years for which the energy saving potentials were estimated.

This table reveals that the iron and steel industry is the branch with the highest absolute conservation potentials. It also has the highest relative electricity conservation potential.

Iron and steel, Ceramics, Chemicals, Pulp and paper, Cement, Non-ferrous metals, Food and beverage are consume more energy in the Brazilian industry. The producers of non-ferrous metals, food and beverage, iron and steel, and pulp and paper are also large consumers of electricity.

5. New approaches for energy efficiency programmes in the industrial sector in Brazil

Brazil never had a broad and long-term public policy for energy efficiency, with agreed on energy savings targets with key stakeholders. The targets should be based on the results of cost–benefit analysis of efficient technologies and good practices. Deadlines to reach the targets and the responsibilities of each stakeholder should be outlined in the plan detailing the policy (Bajay and Sant'Ana, 2010).

The development of such a policy, with a chapter devoted to energy efficiency gains in the Brazilian industry, is a task for the National Council for Energy Policy (CNPE), the government multi-

Table 1
Evolution of some energy efficiency and CO_2 emissions indicators for industry in Brazil, United States and France from 1990 to 2010.
Source: Enerdata (http://wec-indicators.enerdata.eu/, retrieved on November 21, 2012).

	Units	1990	2000	2010
Brazil				
Energy intensity of industry (at purchasing power parities (ppp))	koe/$05p	0.178	0.182	0.195
Energy intensity of manufacturing (at ppp)	koe/$05p	0.270	0.283	0.303
Energy intensity of chemicals industry (at ppp)	koe/$05p	n.a.	0.252	n.a.
Unit consumption of steel	toe/t	0.625	0.552	0.530
Share of electric process in steel production	%	23.8	20.6	23.7
CO_2 intensity of industry from fuel combustion (to value added) (at ppp)	kCO_2/$05p	0.224	0.278	0.260
Per capita CO_2 emissions of industry from fuel combustion	tCO_2/cap	0.361	0.522	0.562
United States				
Energy intensity of industry (at purchasing power parities (ppp))	koe/$05p	0.246	0.173	0.137
Energy intensity of manufacturing (at ppp)	koe/$05p	0.308	0.203	0.161
Energy intensity of chemicals industry (at ppp)	koe/$05p	0.353	0.386	n.a.
Unit consumption of steel	toe/t	0.428	0.353	0.366
Share of electric process in steel production	%	37.3	47.0	61.3
CO_2 intensity of industry from fuel combustion (to value added) (at ppp)	kCO_2/$05p	0.558	0.372	0.287
Per capita CO_2 emissions of industry from fuel combustion	tCO_2/cap	3.01	2.54	1.87
France				
Energy intensity of industry (at purchasing power parities (ppp))	koe/$05p	0.115	0.105	0.085
Energy intensity of manufacturing (at ppp)	koe/$05p	0.156	0.145	0.134
Energy intensity of chemicals industry (at ppp)	koe/$05p	0.353	0.238	n.a.
Unit consumption of steel	toe/t	0.427	0.325	0.368
Share of electric process in steel production	%	28.4	40.3	36.3
CO_2 intensity of industry from fuel combustion (to value added) (at ppp)	kCO_2/$05p	0.298	0.241	0.198
Per capita CO_2 emissions of industry from fuel combustion	tCO_2/cap	1.64	1.45	1.09
China				
Energy intensity of industry (at purchasing power parities (ppp))	koe/$05p	0.482	0.229	0.235
Energy intensity of manufacturing (at ppp)	koe/$05p	0.504	0.250	0.262
Energy intensity of chemicals industry (at ppp)	koe/$05p	0.583	0.389	n.a.
Unit consumption of steel	toe/t	0.918	0.730	0.443
Share of electric process in steel production	%	21.1	15.7	9.78
CO_2 intensity of industry from fuel combustion (to value added) (at ppp)	kCO_2/$05p	1.570	0.619	0.552
Per capita CO_2 emissions of industry from fuel combustion	tCO_2/cap	0.778	0.691	1.490

n.a.: not available.

Table 2
Absolute and relative energy conservation technical potentials, in toe and in %, respectively, for energy-intensive industrial branches in Brazil.
Source: Bajay et al. (2009).

Industrial branches	Year	Heat		Electricity		Total	
		Abs. pot. (toe)	Rel. pot. (%)	Abs. pot. (toe)	Rel. pot. (%)	Abs. pot. (toe)	Rel. pot. (%)
Iron and steel	2007	5,774,921	34.7	1,048,073	66.4	6,822,994	37.4
Ceramics	2007	1,464,345	41.0	28,427	10.0	1,492,772	38.9
Chemicals	2006	1,284,667	23.4	188,973	10.0	1,473,640	20.0
Pulp and paper	2006	1,273,035	19.0	160,259	12.0	1,433,294	17.9
Cement	2007	912,958	30.4	144,147	38.8	1,057,105	31.3
Non-ferrous metals	2006	415,132	16.5	398,981	12.6	814,113	14.3
Food and beverage	2004	260,404	1.6	257,113	15.1	517,517	2.9
Glass	2007	222,831	46.3	0	0	222,831	44.5
Lime	2007	172,191	23.0	50,105	64.6	222,296	27.0
Mining	2007	0	0	212,921	22.9	212,921	6.4
Textiles	2005	129,990	24.0	62,219	9.4	192,209	16.0
Foundries	2007	57,328	22.2	65,881	24.1	123,208	23.1
Iron alloys	2007	0	0	87,725	11.8	87,725	4.9

ministry body responsible for elaborating the main energy policies in Brazil.

The Council could follow the same procedure of the European Commission, launching initially a policy proposal to be discussed by the stakeholders. After the appraisal of their critics and proposals, CNPE would publish an enhanced and final version.

It is important to keep in mind that advances in energy efficiency in the Brazilian industry will bring not only energy savings, but also environmental benefits and better competitiveness, affecting, therefore, not only the Ministry of Mines and Energy (MME), but also the Ministry of Environment and the Ministry of Development, Industry and Commerce. All these ministries are members of CNPE.

An executive agency, subordinated to MME and with strong ties to Eletrobras and Petrobras, could effectively manage the large resources basis needed to turn energy efficiency programmes into meaningful alternatives for additional expansion of energy supply in the country.

This upgrade in energy efficiency programmes in Brazil is only possible if effective mechanisms for measurement and verification (M&V) are deployed in all programmes, and if there is a reasonable degree of decentralization of these programmes in terms of the states of the federation, as it occurs, for example, in the USA. These two goals could be more easily achieved with the existence of an executive agency, rather than with the current institutional arrangement.

Industrial Assessment Centres could be created within the states of the federation, like in the United States, funded by this agency. This would make possible a closer relationship with industry, providing technical guidance on energy efficiency measures, setting up specific M&V procedures for some industrial branches, certifying reliable energy service companies (ESCOs) and carrying out energy audits in some cases. An important role of these centres would be to survey and register the impacts, on energy demand and emissions, of local industries' energy efficiency actions and programmes.

These Assessment Centres would also be responsible for training technical personnel through partnerships with local universities, non-government organizations and R&D centres.

Voluntary programmes between the government and energy-intensive industries should be created in Brazil, following the successful experiences of countries such as Japan, USA, Denmark, Sweden and China (Bajay and Sant'Ana, 2010; Thollander et al., 2012; Bertoldi and Rezessy, 2011; Stenqvist and Nilsson, in press; Lindén and Carlsson-Kanyama, 2002; Tanaka, 2011; Thollander et al., 2007; Thollander and Dotzauer, 2010; Hu, 2007; Eichhorst and Bongardt, 2009; Price, 2005; Thollander et al., in press). These programmes should include best practice guides, benchmarking, technical training, M&V guidelines, jointly funded R&D projects, tax reductions for energy efficient equipments and credit facilities, in exchange for energy saving targets and verifiable results.

Overall, voluntary agreements have been viewed in several countries as an innovative and effective means to motivate industry to improve energy efficiency and reduce greenhouse gas emissions.

Best practice guides and funding facilities should also be available for non-energy-intensive industries, together with tax incentives for the adoption of efficient crosscutting technologies, such as electric motors and boilers.

Energy management standards have been adopted in recent years by many industrial companies in both developed and developing countries. The ISO 50001 standard, compatible with the family of standards ISO 9000, for quality, and the ISO 14000 family of standards for environment, was launched recently. The National Confederation of Industry (CNI) and the energy-intensive industries' associations should encourage their members to adopt the new standard and help them in the implementation process, regardless of new government incentives for energy efficiency, since substantial benefits for the companies can accrue from doing that in any case.

6. Conclusion

Experience from around the globe shows that attention to governance arrangements is a necessary condition for effectively meeting energy efficiency goals (IEA, 2010). According to the International Energy Agency, enabling frameworks, institutional arrangements and co-ordination mechanisms form the core elements of good energy efficiency governance. The most straightforward way to gauge the effectiveness of an energy efficiency governance scheme is to examine outcomes or results, rather than the scheme itself.

This paper shows that despite the efforts the Brazilian government put on some industrial energy efficiency programmes since the eighties, the results obtained so far with such programmes have been very limited.

In the other hand, a recent study revealed that several energy-intensive industrial branches in Brazil have large energy savings potentials, both for electricity and heat. Much of these potentials can be captured through policies for promoting use of energy-efficient industrial equipment and improving overall efficiency through energy management.

Comparisons, carried out in this paper, between the Brazilian experience with industrial energy efficiency programmes and the experiences of thirteen other countries with such programmes paved the way to proposals of some new approaches the Brazilian Government and industry associations in the country can adopt, with emphasis on the governance issue, to mitigate the strong barriers that hinder a substantial upgrade of energy efficiency in the local industry.

As mentioned in Section 2 of this paper, with the exception of legislation and regulation mandating energy efficiency programmes and energy saving targets in industry, all industrial energy policies observed elsewhere in the comparative study referred to above and not applied in Brazil yet are "low hanging fruits", i.e., they could easily be adopted in the country in the short term.

The proposals presented in the previous section contemplate: (i) **administrative measures** that the Brazilian government could take, such as formulating a broad and long-term public policy for energy efficiency, with agreed on energy savings targets with key stakeholders, and the creation of an executive agency and industrial assessment centres to run government's energy efficiency programmes for industry and other sectors of the economy; (ii) **economic measures,** such as voluntary programmes between the government and energy-intensive industries, involving tax and credit incentives, energy saving targets and M&V procedures, and tax incentives for the adoption of efficient crosscutting technologies by non-energy-intensive industries; and (iii) **improving the current informative policies**, with emphasis on decentralized actions carried out by the industrial assessment centres, particularly for small and medium size companies.

It is interesting to point out that the problems depicted in this paper caused by the lack of appropriate energy policies for the Brazilian industry are also found in several other developing countries, and the proposed solutions here are also applicable for them. China, for instance, has been achieving success in recent years fostering energy service markets for ESCOs and implementing voluntary agreements with industrial branches.

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